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AN EVALUATION OF DISEASES IN THE ORANGE CRUSH TIMBER SALE AREA, GROVELAND RANGER DISTRICT, STANISLAUS NATIONAL FOREST

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ABSTRACT

A stand within the Orange Crush Timber Sale Area on the Groveland Ranger District was evaluated for disease pests. Numerous pathogens were found in the area, but none was currently causing significant tree injury. Potentially harmful diseases could all be mitigated through silvicultural treatments that foster good tree health.

OBSERVATIONS

A visit to the Orange Crush Timber Sale area was completed on September 18, 1995 by John Pronos, Forest Pest Management - South Sierra Shared Service Area, and Lynn Webb, Groveland Ranger District, Stanislaus National Forest. The area examined occupied about 80 acres of second growth trees in the mixed conifer type (M3G) at an elevation of 4400 feet and just west of Yosemite National Park. The stand is covered under the Crush EA as far as management, and it is part of the Orange Crush Timber Sale. Site quality is good (FS Site Class II) and tree species present, in order of abundance, include ponderosa pine, incense-cedar, Douglas fir, sugar pine, white fir and California black oak.

Stocking varied greatly over the site (80-240 sq. ft./acre). Standing recent mortality was rare because the area had been salvaged within the last few years. Based on the stumps present, ponderosa pine and white fir accounted for most of the salvage. The pattern of mortality, species killed, and drought conditions preceeding mortality all suggest that bark and engraver beetles were involved. Salvage activities created a few nonstocked or sparsely stocked locations, but much of the area remains densely stocked with trees 18 inches DBH or less.

Diseases Present

Several tree pathogens were present on the site, but none was currently causing significant problems. However, these pests are viable, have the potential to become worse over the long term, and should be considered in the management of the stand. Below is a discussion of the diseases on the site and their potential to affect tree health. General descriptions of each pest's biology are included at the end of this report in Appendix 1.

DWARF MISTLETOE: Western dwarf mistletoe (Arceuthobium campylodpodum) was found in one pocket on ponderosa pines 10 inches DBH and larger. Some of these pines were severely infected (Hawksworth ratings of 5 or 6), and had live crown ratios of less than 30%. Such trees are in very poor health and would not likely recover from or outgrow the mistletoe. Their lowered vigor also make them very susceptible to bark beetle attacks. It is very difficult to maintain uneven-aged stands in a healthy condition when mistletoe is well established. The horizontal and vertical structure of uneven-aged stands provides conditions that favor the maximum spread of this pathogen.

The two tables below display the effect that western dwarf mistletoe has on ponderosa pine growth and mortality. This information is included to demonstrate that, if left untreated, dwarf mistletoes can eventually have serious effects on pine stands. (From "Hawksworth, F.G., et. al. 1992. Interim dwarf mistletoe impact modeling system - Users guide and reference manual. USDA Forest Service, Methods Application Group, Fort Collins, CO. Report MAG-91-3. 90p.)

Table 1. Ten-year growth reductions in ponderosa pine based on Hawksworth mistletoe rating.

HAWKSWORTH MISTLETOE RATING:	0	1	2	3	4	5	6
10-YEAR DIAM GROWTH REDUCTION (PERCENT)	0	0	0	2	14	27	50

Table 2. Ten-year mortality percentages for ponderosa pine based on Hawksworth rating and tree size.

HAWKSWORTH MISTLETOE RATING:	0	1	2	3	4	5	6
% MORTALITY TREES <9" DBH	0.0	1.2	3.9	8.8	16.0	25.4	37.0
% MORTALITY TREES >9" DBH	0.0	1.0	3.3	7.4	13.3	21.2	30.9

If dwarf mistletoes are causing unacceptable injury to pines, they can be effectively controlled using standard silvicultural treatments. The key is to

treat this pathogen before it reaches severe levels. Unfortunately, dwarf mistletoes are often ignored because it takes so long for them to build up to damaging proportions. In this stand, infections are moderate to severe but restricted to a small area. The best approach would be to eliminate most of the infections and reduce the mistletoe to an insignificant level. This could be accomplished primarily through removal of infected trees and perhaps some pruning, if affordable. At a minimum, dwarf mistletoe infections should be used as a factor in identifying trees that should be removed during thinning.

BLACK STAIN ROOT DISEASE: This disease is caused by a fungus (Leptographium wageneri) that kills trees by obstructing the water conducting tissues and does not decay wood. It was found on two declining adjacent Douglas firs, one 16 inches DBH and one 14 inches DBH. Both trees had sparse crowns with pitch streaming on the lower 4 feet of the bole. Chopping into the outer sapwood at the base of the tree revealed characteristic dark brown to black staining occurring in arcs that followed the annual rings.

Douglas fir is a small component of the stand, and these were the only two trees found with the disease. Black stain is uncommon in other areas of the Groveland District and the Stanislaus Forest. Three variants of L. wageneri occur in California - one infects pinyon pine, one infects hard pines, and one infects Douglas fir. Our stand evaluation indicates that only black stain affecting Douglas fir is present. The pathogen may spread locally from tree to tree where roots are in contact, and it may grow short distances through the soil. Root inhabiting insects, which may be attracted to stressed trees and disturbed sites, probably account for long distance spread. The widely scattered distribution and small amounts of this disease on the Groveland District suggests that insects initiate most of the infections.

WHITE PINE BLISTER RUST: This disease is caused by a fungus (Cronartium ribicola) that was introduced into California about 1930. Since that time it has spread throughout the forests in the Cascades and Sierra Nevada. Blister rust is especially lethal to young 5-needle pines with most damage occurring on sugar pine. Inactive rust cankers were common on seedling and sapling size sugar pine in the Orange Crush stand - only one seedling was found with sporulating (active) cankers. Many areas in the stand had no sugar pine regeneration, but it was not possible to assess the role of rust in sugar pine mortatity. However, this disease is capable of eliminating most of the small sugar pine left in the stand over the next decade or two.

BACTERIAL GALL: In one location, several small, suppressed Douglas firs had conspicuous rough, round galls (a little larger that a golf ball) on the upper stem. Damage to these trees from the galls was not apparent. This disorder is identical to what has been called bacterial gall of Douglas fir. Some research reports have implicated the bacterium Pseudomonas pseudotsugae, while others have been unable to verify this organism as the causal factor. At any rate, this disorder is mainly cosmetic but in some cases may kill the tops of small trees or cause a slight reduction in growth. Management action solely for this disease is not justified, but the presence of galls could be used as a selection factor in marking guides for stand entries.

OZONE INJURY: A single pole-size ponderosa pine was found with symptoms of injury due to the air pollutant ozone. The symptom, called chlorotic mottle,

was found only on this tree's oldest foliage (3 years). Ozone injury to sensitive ponderosa and Jeffrey pines is common in much of the central and southern Sierra Nevada, especially pine stands below 6000' elevation. While some areas in the Sierra are significantly stressed by air pollution, the amount of injury in the Orange Crush stand would be considered very slight.

MANAGEMENT OPTIONS

None of the diseases in the Orange Crush stand is currently serious enough by itself to warrant immediate or direct action. However, future entries into the area provide an opportunity to mitigate potential disease effects. The two options below provide a prognosis for the stand if no action is taken, or if efforts to improve tree health are employed.

1. NO ACTION: The consequences of doing nothing in this stand would result in diseases like dwarf mistletoe gradually intensifying, which would reduce tree growth and/or cause tree mortality. Uneven aged stands do not outgrow existing dwarf mistletoe infestations. Over time, between-tree competition will intensify, particularly in already overstocked aggregations, which will increase the probability of bark and engraver beetle damage.

   Natural sugar pine regeneration would continue to be exposed to lethal infections of blister rust, which vary from year to year and cannot be accurately predicted. Black stain is restricted to Douglas fir but could spread to adjacent healthy Douglas fir if their roots grow near infected roots. It would probably remain at very low frequencies. Some of these effects may be viewed as beneficial to the ecosystem by providing wildlife snags and down woody material.

2. REGULATE STOCKING TO IMPROVE TREE HEALTH: Entries designed to reduce the basal area of overstocked aggregations can increase residual tree vigor, provide the opportunity to eliminate undesirable trees, and reduce the long-term potential for bark beetle related mortality. Marking guides should include identifying diseased trees and considering them for removal. All pines heavily infected with dwarf mistletoe should be strong candidates for removal. Lightly and moderately infected pines should be removed if they are providing sources of infection for understory trees.

   Caution must be exercised when treating this stand in relation to white pine blister rust and black stain root disease. Any activities that would increase the amount of Ribes species would favor the development of blister rust. Creating small openings may stimulate the establishment of Ribes and provide environmental conditions that foster successful blister rust infection on pine. These effects can be offset by planting rust resistant sugar pine. Major site disturbances such as road building and logging may create conditions conducive for black stain root disease. Because black stain is currently at such low levels and restricted to Douglas fir, stand entries, and the resulting site disturbance, would not be expected to increase black stain incidence to significant levels. In other words, it is not necessary to initiate any specific actions against black stain root disease.

APPENDIX - BIOLOGIES OF PATHOGENS

Western Dwarf Mistletoe

Dwarf mistletoes (Arceuthobium spp.) are parasitic, flowering plants that can only survive on living conifers in the Pinaceae. They obtain most of their nutrients and all of their water and minerals from their hosts. Western dwarf mistletoe (A. campylopodum) infects principally ponderosa, Jeffrey, and knobcone pines, and occasionally Coulter and lodgepole pines.

Dwarf mistletoes spread by means of seed. In the fall the fruit ripen and fall from the aerial shoots. The seeds are forcibly discharged. The seed is covered with a sticky substance and adheres to whatever it contacts. When a seed lands in a host tree crown, it usually sticks to a needle or twig, where it remains throughout the winter. The following spring the seed germinates and penetrates the twig at the base of the needle. For the next 2-4 years, the parasite grows within the host tissues, developing a root-like system within the inner bark and outer sapwood, and causing the twig or branch to swell. Aerial shoots then develop and bear seed in another 2-4 years.

Dispersal of dwarf mistletoe seeds is limited to the distance the seeds travel after being discharged. From overstory to understory, this is usually 20 to 60 feet, but wind may carry them as far as 100 feet from the source. A rule of thumb is that the seeds can travel a horizontal distance equal to the height of the highest plant in an infected tree. There is some evidence that long distance spread of dwarf mistletoe is occasionally vectored by birds and animals.

Vertical spread within tree crowns of most dwarf mistletoes is limited to less than one foot per year because of foliage density. Because of the thin crowns of Digger pine, however, the vertical rate of spread has been measured as being greater than 2 feet per year. This rate of spread equalled or exceeded the rate of height growth of infected trees.

Dwarf mistletoes are easy to identify because they are generally exposed to view within a tree's crown. Signs of infection include the yellow-green to orange mistletoe plants, basal cups on a branch or stem where the plants were attached, and detached plants on the ground beneath an infected tree. Symptoms include spindle-shaped branch swellings, witches' brooms in the lower crown, and bole swellings.

Black Stain Root Disease

Black stain root disease is caused by the fungus Leptographium (Ceratocystis) wageneri (asexual state Verticicladiella wageneri). In California, the fungus has three host specific strains that infect either ponderosa and Jeffrey pine, singleleaf pinyon pine, or Douglas-fir. In most situations, the fungus does not cross over between species, even in mixed species stands.

Initiation of disease centers probably occurs when spore-carrying, cambium-feeding beetles invade tree roots and transmit the spores of the fungus to the tree. The fungus then grows in the wood of the root toward the root collar.

Once the fungus becomes established in a tree, it spreads locally between trees through rootlet contact or fungus growth through the soil for short distances and direct infection of small feeder roots. The rate of underground spread in a ponderosa pine stand is highly variable and dependent on species composition, stand density, and site; on the Georgetown Divide, El Dorado County, the average annual radial spread was 4 feet (range 0 to 20 feet). The rate is not substantiated for Douglas-fir, although it appears to be faster than in pine.

The disease can be identified in a tree by the dark brown to black stain of the wood. This stain occurs as arcs that follow the annual rings. The amount of stain around the bole varies among trees. It may involve only a small part of the tree's circumference or it may encircle the tree. The stain may be one to many annual rings deep.

Infected trees undergo gradual to rapid crown decline prior to mortality. Symptoms of crown decline include reduced terminal growth, needle yellowing and shortening, and premature loss of foliage. Trees pole-size and larger may also bear a heavy cone crop. Bark and engraver beetles can successfully attack and kill infected trees. Douglas-firs may have grayish-blue resin streaming from the bark above the stained area.

Limited information is available on stand and site characteristics associated with the disease. On the Georgetown Divide, pure or predominantly ponderosa pine stands with moderate to high stand densities had a higher probability of being infected. The disease appeared to be limited to an elevational band of 4000 to 5000 feet. A characteristic of the disease in Douglas-fir is its higher incidence along roads and in young plantations or dense natural regeneration.

White Pine Blister Rust

Blister rust (Cronartium ribicola) is caused by an obligate parasite that attacks sugar and western white pines and several species of Ribes. The fungus needs the two alternate hosts to survive, spending part of its life on 5-needled pines and the other on Ribes. The disease occurs throughout the range of sugar pine to the southern Sierra Nevada, but has not been reported further south. Infection of pines results in cankers on branches and main stems, branch mortality, top kill, and tree mortality.

Spores (aeciospores) produced by the fungus in the spring on pine bole or branch cankers are wind-disseminated to Ribes where they infect the leaves. Spores (urediospores) produced in orange pustules on the underside of the leaves re-infect other Ribes throughout the summer, resulting in an intensification of the rust. A telial spore stage forms on Ribes leaves in the fall. Teliospores germinate in place to produce spores (sporida) which are wind-disseminated to pines and infect current year needles. Following

infection, the fungus grows from the needle into the branch and forms a canker. After 2 or 3 years, spores are produced on the cankers and are spread to Ribes to continue the cycle. Although blister rust may spread hundreds of miles from pines to Ribes, its spread from Ribes back to pines is usually limited to a few hundred feet.

Branch cankers continue to enlarge as the fungus invades additional tissues and moves toward the bole. Branch cankers within 24 inches of the bole will eventually form bole cankers (these are called **lethal** cankers). Bole cankers result in girdling and death of the tree above the canker. Cankers whose closest margins are more than 24 inches from the main bole are unlikely to reach the bole and only branch flagging will result (these are called **non-lethal** cankers).

Environmental conditions are critical for successful infection and limit the disease in most years. Moisture and low temperatures favor infection of both hosts, and must coincide with spore dispersal for infection to occur. In California, these conditions occur only infrequently, usually in cool moist sites such as stream bottoms or around meadows. In so called "wave years" when favorable conditions occur, high levels of infection can result. Wave years in California have occurred at approximately ten-year intervals in the past. As one moves from sites most favorable for rust to less favorable sites, the frequency of wave years decreases.

Air Pollution (Ozone)

Ozone is the primary ingredient in "smog" that is harmful to California trees and forests. It is a secondary photochemical product resulting from the action of sunlight on hydrocarbons and oxides of nitrogen. The predominant source of these precursors is internal combustion engine exhaust, which is usually formed in urban areas many miles from National Forests.

Ponderosa and Jeffrey pines are two of the most sensitive tree species to ozone in California and are used as bioindicators of ozone injury in damage studies and surveys. Ozone is taken up by foliage, along with other atmospheric gases, through the stomates. Once inside the needle tissue, ozone disrupts several biochemical pathways and leads to the destruction of chlorophyll. The end result is reduced photosynthetic capacity plus premature loss of older needles. Oddly enough, pines under moisture stress are less active photosynthetically, and take up less pollution. Ozone injury to drought stressed trees is usually lower than to trees with adequate moisture.

Forest managers often feel helpless to deal with ozone injury since the pollutants are not produced on their forest, but are transported from urban areas. Natural populations of pines show great variation in their sensitivity to air pollution. Ozone, along with other stress factors and pests, may play a part in the death of sensitive individuals. Collecting seeds for regeneration from trees that show no symptoms of air pollution injury is important. Minimizing the stresses from competing vegetation may allow moderately sensitive trees to withstand the effects of air pollution. Managing for resistant species (see table below) may offset the impact of ozone.

Sensitivity of California Forest Trees To Ozone Injury

SENSITIVE	INTERMEDIATE	TOLERANT
Ponderosa pine	White fir	Sugar pine
Jeffrey pine	Incense-cedar	Douglas-fir
Monterey pine	Knobcone pine	Giant sequoia
California sycamore	Coulter pine	Redwood
Quaking aspen	Big-cone Douglas fir	Western juniper
California black oak	Lodgepole pine	Digger pine